NETWORK INFRASTRUCTURE UPGRADE FOR SECURITY SYSTEMS – PHASE 2

ConnDOT Project No. 300-0178/301-0108
STV Project No. 4015017

for

Metro North Railroad - New Haven Main Line
Westport to Stratford

60% DESIGN DEVELOPMENT REPORT

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Background and System Overview

STV Incorporated (STV) was selected to provide engineering services to the Connecticut Department of Transportation (DOT) relative to the Closed Circuit Television (CCTV) security upgrade along the Metro-North Railroad (MNR) New Haven Main Line. This includes establishing the network infrastructure to support a new CCTV system at the passenger stations and bridges and the interface to the fiber backbone at the passenger stations. The Metro-North Railroad New Haven Line in Connecticut is owned by the DOT and operated and maintained by Metro-North Railroad (MNR). Sections of the fiber optic backbone are being installed as part of this project and various catenary and signaling upgrade projects currently in development or construction.

STV will use the information gathered during the Feasibility (PE) Phase, Phase 1 design and construction, along with MNR standard specifications and special/general provisions to develop final drawings and specifications. The final contract documents will contain the necessary design information for the CCTV and communications systems, and required multidisciplinary engineering efforts at the passenger stations, PECK Bridge, and backbone network deployment.

STV will produce design contract documents for the following locations:

- 5 Passenger Stations – Stratford, Bridgeport, Fairfield Metro, Fairfield, and Southport
- PECK Movable Bridge (Mile Point 55.90)
- Right-of-Way from catenary structure No. 632* (Mile Point 47.38) to No. 777 (Mile Point 55.50)
- Communications equipment to be installed in three node houses:
    - Node House 473 (Greens Farms)
    - Node House 505 (Fairfield)
    - Node House 559 (Bridgeport)

*Right-of-Way has been extended from 639 to 632 from the 30% submission.

The proposed system expands the Phase 1 system, consisting of CCTV cameras, video recording equipment, aerial duct and conduits, a 10Gb fiber optic backbone, and a 1Gb fiber optic local network. There is a 144-strand fiber optic cable on both the north and south sides carrying video between each station and bridge, the New Haven Yard CCO Shop and a backup location at the T&E building. The communications system will be Ethernet on a Cisco DWDM (Dense Wave Division Multiplexing) system and configured as redundant rings. The head-end CCTV system currently being deployed under Phase 1 will be expanded to accommodate the new cameras.

The design drawings and specifications will clearly identify demarcation points between the Contractor and MNR's division of work and show the interface with other projects that are currently (or will be) in construction at the time of this project. In addition to current DOT and MNR specifications, all relevant national and local safety and performance codes, standards, and specifications will be adhered to, and the contract documents will provide all of the detail necessary for a fully functional system ready to be advertised for bid.

The previously submitted 30% Schematic Design served the purpose to convey the overall concept of the project, which includes CCTV camera and cabinet locations, high-level block diagrams, and overall system architecture. The 60% Design Development Plans build upon the 30% design by incorporating comments received from ConnDOT and MNR, and add more detailed cabinet and device locations, fiber optic cable and power cable routings, communications system block and connection diagrams, cabinet details and layouts and other detailed features of the project. This report presents a synopsis and supplemental information for the work performed to bring the 30% Schematic Design to the level of 60% Design Development Plans and includes areas that require further discussion.

60% Design Development

This report will focus on presenting the key revisions and additions that were made to the design for this 60% submission, as well as key areas where details will be provided in future submittals. In addition to addressing the comments provided on the 30% submission, STV has addressed camera location comments made by MNR security, modified the camera architecture to Power over Ethernet (PoE), and the inclusion of 60% specifications.

1. Power over Ethernet (PoE)/Copper Ethernet

After the 30% submittal, DOT and MNR expressed a desire to use copper Ethernet for future deployments, which could reduce the number of maintenance items and failure points. MNR is currently moving towards a PoE solution in other areas (mainly in New York) and do have limited installations in Connecticut at Bridgeport and Stamford Yards, though there has been concern over electromagnetic interference (EMI) in catenary territory.

STV conducted a limited network test at Fairfield Metro Station on August 25, 2015. This test used two network analyzers to transmit Ethernet signals at 1Gbps using a 300ft unshielded Category 5E/6 cables strung along the canopy as close as possible to the catenary wires. Over the nearly three hours of testing, several Amtrak Acela, Amtrak Regional, and Metro-North trains passed by or stopped at the station. No transmission errors occurred. A full test report will be provided under separate cover.

In accordance with MNR and DOT direction, the 60% design has been updated to include a PoE architecture. Where cabling extends more than 300ft from the cabinet, additional remote switches have been added. The remote switch has spare capacity to serve as access point for future devices or connect to additional future field switches. This was based on a request from MNR Security. Additional details about the remote switches are provided later in this report.

2. Camera Placement

A review meeting was held with MNR Security after the 30% submission to discuss camera placement methodology and specific camera locations. Based on MNR Security comments, the following changes were made:

- Cameras generally face towards an oncoming train at stations.
- PTZ cameras at stations were replaced by 2 fixed cameras. PTZ cameras were only included at PECK Bridge where it may be beneficial for the bridge operator.
- Reduction of the number of cameras at PECK Bridge. The 30% design was based on Devon Bridge, but PECK Bridge is much less obstructed than Devon Bridge. Also, full high definition cameras enable better coverage area compared to Phase 1 camera specifications. Further reductions may be possible and will be discussed with MNR.

The revisions resulted in 6 additional cameras, summarized in the table below.

Location	30% Design			60% Design			Change		
	Fixed	PTZ	Total	Fixed	PTZ	Total	Fixed	PTZ	Total
Stratford	8	4	12	14	0	14	6	-4	2
PECK Bridge	15	16	31	17	7	24	2	-9	-7
Bridgeport	17	4	21	24	0	24	7	-4	3
Fairfield Metro	27	4	31	34	0	34	7	-4	3
Fairfield	12	4	16	18	0	18	6	-4	2
Southport	7	4	11	14	0	14	7	-4	3
Total	**86**	**36**	**122**	**121**	**7**	**128**	**35**	**-29**	**6**

Although the total number of cameras increased slightly, the total camera cost is expected to decrease as the basis-of-design PTZ cameras cost nearly 3 times more than the fixed cameras. The basis-of-design cameras are discussed in further detail below.

3. Cameras

Metro-North is trying to standardize on Axis cameras but understands that Verint cameras were used for Phase 1. For ease of service and maintainability, Metro-North would prefer Axis or Verint cameras for Phase 2. As a basis-of-design, STV has chosen the Axis Q3505-VE fixed camera and the Axis Q6044-E PTZ camera. These cameras were chosen for their advanced features such as electronic image stabilization, day/night capability with automatic IR cut filter, wide dynamic range, vandal resistance, and high definition resolutions. Both cameras are compatible with the Verint Nextiva Video Management System currently being deployed in Phase 1.

The key specifications of these cameras are summarized in the table below. It is important to note that many of these features are available from other manufacturers.

		Axis Q3505-VE (Fixed)	Axis Q6044-E (PTZ)
Sensor		CMOS 1/2.8"	CMOS 1/3"
Lens	*Focal Length*	Varifocal. Option of 3-9mm or 9-22mm	Motorized 4.4-132mm
	Remote Focus and Zoom	Yes	Autofocus
	Automatic removable IR cut filter	Yes	Yes
	Auto Iris	P-Iris (improved depth of field)	Yes
Video Compression		H.264, MJPEG	H.264, MJPEG
Max Resolution		1920x1200	1280x720 (720p)
Frame Rate		30fps at 1080p resolution and WDR 60fps at 1080p resolution without WDR	30fps all resolutions
Wide Dynamic Range (WDR)		Up to 120dB	Yes
Electronic Image Stabilization		Yes	Yes
Enviornmental	*Enclosure*	IP-66/67, NEMA 4X	IP66, NEMA 4X
	Impact	IK10+ (50 joules)	IK10
	Dehumidifying Device	Yes	
	Temperature Range	-40 to 140 degrees F (10-100% RH condensing)	-58 to 122 degrees F (10-100% RH condensing)
	Heater	No	Yes
Power		PoE (802.3af)	60W PoE
Built-in IR Illuminator		No	No
Minimum Illumination	*Color*	.18 lux with Lightfinder at 30fps .28 lux for 22mm lens model	.2 lux at 30IRE
	B/W	.04 lux with Lightfinder at 30fps .06 lux for 22mm lens model	.04 lux at 30IRE
Railroad EMC standards		EN 50121-4, IEC 62236-4	EN 50121-4, IEC 62236-4
Verint Compatible		Yes	Yes

4. Camera Poles and Mounting Details

Preliminary pole designs have been included on drawing FCI-590. "Type A" mast pole has been proposed for most cameras where a station canopy does not exist in order to provide a view as close to the edge of the platform as possible. "Type B" poles will generally be used at the end of platforms, where the pole can be closer to the platform edge without interfering with passenger flow. The Type B pole is also proposed next to catenary pole 688A for camera FFS-15 at Fairfield Station.

An alternative to Type A that provisions for a future variable message sign has also been provided for further discussion. Attachments to the existing variable message sign poles are also being investigated but have not been included in the 60% design.

Preliminary canopy mounting details have been included on drawing FCI-591. Attachment details of the cameras and IR lights at PECK Bridge have not yet been determined.

Camera mounting and pole details will be further developed for the 90% submission.

5. CCTV Cabinets

<u>Station CCTV Cabinets</u>

The main station CCTV cabinets have been designed similar to the Phase 1 base mounted cabinets. The network switches have been updated to the newer Cisco IE5000 (replacing the IE3010 from the 30% design).

With the change in system architecture to Power over Ethernet, we were able to eliminate CCTV power supplies from station cabinets. These power supplies were not hardened and required the cabinet to have a heater for cold temperatures and cooling fan for high temperatures. Since the network switches have a temperature range from -40˚F to 140˚F, a heater/fan will not be necessary in the new cabinets.

The proposed cabinet is shown on drawing FCI-580.

Remote CCTV Cabinets

Remote CCTV Cabinets have been added at Bridgeport, Fairfield Metro, and Fairfield Stations for locations where the cabling would extend more than 300ft from the main CCTV cabinet. These remote CCTV cabinets have been designed to use minimal space (20”x20”x8”) and power up to 7 cameras while providing a spare maintenance port. The current design uses a Cisco IE4000 switch, but can also accommodate other field switches (such as Etherwan) with minimal design changes.

The remote cabinets will be located on the outside face of the station platforms at Fairfield Station and the westbound platform of Fairfield Metro Station. At Bridgeport Station and eastbound Fairfield Metro Station, the under-platform areas are not accessible so the cabinets will be located on the platform.

The proposed cabinet is shown on drawing FCI-581.

PECK Bridge CCTV Cabinets

The CCTV Cabinets at PECK Bridge will be similar to the main station CCTV cabinets. Due to the high power requirements of the PTZ camera, an additional network switch was added that supports 60-watt PoE. This was chosen over a power injector (i.e. midspan) in order to reduce the possible points of failure. Cisco’s industrial/hardened product line does not currently support 60-watt PoE (referred to as “Universal PoE” by Cisco) so the Etherwan EX78900 Series has been used as the basis-of-design.

The infrared illuminators on the bridge will require additional power supplies. STV is currently evaluating different options for this power supply, but may require a rack-mounted power supply similar to the CCTV power supplies in Phase 1. This would add a heater/fan assembly and vents to these cabinets to due to the limited temperature range of the power supply. STV will discuss all available options with MNR and the DOT during the design review meeting.

The proposed cabinet is shown on drawing FCI-582.

Equipment in the basement of the Control House will use the existing CCTV rack.

Fairfield Metro Station Eastbound Cabinet

The main CCTV cabinet on the eastbound platform of Fairfield Metro Station will be located in the existing electrical room. Since this room is protected from the outside environment, a standard enclosed rack (similar to the existing public address rack) will be considered for this location.

Remote Cabinets at Southport and Stratford Stations

MNR Security expressed a desire to include remote cabinets for future use closer to the ends of the platforms for all stations. Remote CCTV cabinets were not necessary at Southport and Stratford Stations because of the short length of these platforms. The CCTV cabinets were located towards the middle of the platform and the cabling did not exceed the 300ft limitation of copper Ethernet. STV will discuss the options with MNR and DOT to determine if remote cabinets should be added at these locations.

6. Station Power Sources

During our field visits, MNR Power Dept. preferred to have cabinets powered from their power panels whenever possible. At Fairfield Metro, Bridgeport, and PECK Bridge, our design uses state-owned power panels that can be accessed by MNR. Other stations are maintained by the local Towns and will require coordination. Sketches with available power sources were provided to DOT on July 20, 2015 for discussion with the Towns, MNR, and DOT.

Stratford Station

There is an existing Metro-North power panel on the west end of the westbound platform. The current design uses this panel to power both the eastbound and westbound CCTV cabinets. A conduit will cross catenary 840 to feed the eastbound CCTV cabinet. Additional Town power panels are available in the eastbound station building that would eliminate the power run across the catenary structure and reduce the size of the power wiring.

Fairfield Station

Metro-North has a power panel outside the westbound station building. The current design uses this panel to power both the eastbound and westbound CCTV cabinets. A conduit will cross catenary 687A to feed the eastbound CCTV cabinet. Additional Town power panels are available in the eastbound station building that would eliminate the power run across the catenary structure and reduce the size of the power wiring.

Southport Station

Southport Station is maintained by the Town of Fairfield. There is a Metro-North power panel in the westbound station building which will be used for the westbound CCTV cabinet. Due to the offset layout of the station, it is not feasible to run power from the MNR power panel to the eastbound platform. As a result, the eastbound Town power panel has been proposed for use on the eastbound side. If the Town power panel is not available to this project, a new service would need to be run from the utility company.

7. Fairfield Metro Station

Existing Cameras

Although it was originally anticipated that the existing Fairfield Metro Station cameras would be integrated into this system, it has since been determined that Fusco Management uses that system for operational purposes and has a cellular connection for remote monitoring. In order to maintain that functionality, the existing cameras will remain as a standalone system.

Local Station Duct System

Fairfield Metro Station was built with an underground duct system for local distribution within the station. There are 3 different systems: communications (currently used for public address and variables message signs), normal lighting power, and emergency lighting power. As part of the final design, STV will investigate possible use of these ducts to feed the remote CCTV cabinets to minimize the number of conduits installed through the station.

8. Head-End Modifications

Head-end modifications (additional storage, additional servers, etc.) to the Phase 1 system have not been included in the 60% plans. Since this is currently under construction, head-end changes will be detailed in the 90% plans in order to provide the most accurate information.

9. Infrared Lights

Because there is no lighting at the PECK Bridge, all CCTV cameras will use an external infrared light. Similar to Phase 1, IR illuminators along the Railroad will use covert (940nm) lights. To provide maximum coverage, 850nm lights will be used along the bridge fender. The 850nm lights provide approximately twice the range as equivalent 940nm lights with the same power.

10. Right-of-Way

Building on the 30% Schematic Design, additional drawings have been prepared, consisting of attachment and assembly details, conduit mounting details, grounding of proposed cable to existing catenary structures, and updated cable support schedules. The support schedules on the right-of-way plans provide information such as the attachment type to be used, its arrangement, and type of structure to which it will be mounted at various support locations.

Roadway Overpasses

We have identified four locations that require cable routing over roadway structures:

- Sasco Creed Road (between Catenary 640 & 641)
- Unquawa Road (between Catenary 688 & 689)
- Grasmere Avenue (between Catenary 710 & 711)
- Black Rock Turnpike (between Catenary 721 & 722)

Fiber Starting Location

As a result of MNR C&S comments from the 30% design, the starting point of the fiber optic backbone cables will be Greens Farms Node House (Catenary Structure 632). The figure 8 aerial duct will be run from catenary 632 to 639 by State Project 301-0145 (C-1A/C-2 Catenary Replacement Project, currently under construction), but the fiber will be provided under this project, eliminating a cable splice in the run.

PECK Bridge East Side Fiber Drop

The backbone fiber in the area of PECK Bridge is being run by State Project 301-0145 (C-1A/C-2 Catenary Replacement Project). We have requested DOT add a drop to the east side of the bridge for the east CCTV cabinet. If this is not feasible, a 24-strand fiber will be run in conduit from the east CCTV cabinet to Catenary 783E, aerially across to the bridge to Catenary 783B, and in conduit to the west CCTV cabinet. STV will incorporate this design once DOT verifies the availability of a fiber drop on the east side of the bridge.

Fairfield Metro Station

At Fairfield Metro, MNR has determined the existing communications duct bank that runs under the eastbound platform has available ducts. This is separate from the local station duct system described above. Both the 144-fiber backbone cable and the 24-fiber crossover cable will be routed through this duct bank. The 24-strand drop cable will be spliced to the backbone fiber in the existing manhole outside the electrical room. The final path from the manhole to the electrical room will be determined in the next submission.

On the westbound side, DOT has requested the backbone cable run under the platform. We have provided conduit running the length of the platform for the 60% design and will work with DOT and MNR to explore other options for future submissions.

Slack/Drop Locations

In addition to the slack locations identified by DOT during the 30% design, additional slack has been provided approximately every 1500ft and is identified as “Slack for future use.” Due to changes in the starting location of the fiber, end-of-reel splice locations have not yet been identified but will be included in the next submission. In accordance with Phase 1 design

changes, all splices (except at Fairfield Metro) will be performed aerially using outdoor aerial splice closures.

Based MNR C&S direction, only cable slack at future drop locations will be provided in a snow shoe storage loop. Slack for fiber drops that are used for this project will be coiled at the nearest catenary structure (not installed in snow shoe storage) for splicing by MNR.

Design Development Construction Cost Estimate

A Design Development estimate has been compiled and will be provided to DOT under separate cover.

Work to be Performed for Next Submittal

In addition to general continued development of the design and installation details and addressing comments from DOT and MNR, the following key areas will be further developed:

- CCTV pole details
- CCTV camera and IR mounting details
- Conduit attachment details
- Final specifications
- Head-end modifications
- Additional attachment types and details to address unique circumstances

Design Development Plans and Specifications (Provided Under Separate Cover)

- Network Infrastructure Upgrade for Security
  New Haven Line
  Phase 2
  Westport to Stratford
  Dated September 4, 2015